Journal of Environmental Sciences, Vol., 6, (1993)

SOIL FAUNA UNDER MAJOR SHRUBS IN GRAZED AND PROTECTED PLOTS AT THE OMAYED BIOSPHERE ERESERVE

II.- SPECIES-AREA RELATIONSHIPS

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ABSTRACT

An experiment of protection from grazing was carried out since 1974 with 4 plots of 0, 25, and 50% of the grazing pressure prevailing in the surrounding area. Soil fauna were collected from under major shrubs in grazed and completely protected plots. Number of species of soil fauna, total population density and area of each sampled shrub were determined. Diversity of soil fauni in grazed plots is higher than that of completely protected plots. Number of species increases as the area increases at equal rates in both treatments. Number of individuals increases as the rate increases at a area higher in the completely protected plots than in grazed plots.

Keywords : *Species, Area, Soil Fanua, Mariut, Diversity.*

INTRODUCTION

The western Mediterranean desert of Egypt is one of the arid regions which has a long history of intensive land use, mainly grazing and rain-fed farming. Grazing affects this ecosystem in different ways and rates. It regulates density and cover percentage of desert vegetation directly, while affecting populations of soil fauna indirectly. This will be manifested in species diversity and population density of soil fauna. Comparisons of population density of soil fauna in protected and grazed plots in Omayed Biosphere Reserve were reported by

Ghabbour and Hussein (1978), Cancela de Fonseca et al. (1984), Ghabbour et al. (1991), Mikhail (1991) and Mikhail et al. (1991).

The purpose of the present study, carried out in 1987, is to evalute species-area relationships as affected by prolonged protection from grazing in the Omayed Biosphere Reserve, which is part of Mariut area, west of Alexandria. This area was protected from grazing in 1974, so that the duration of protection till sampling was made in 1987, was 13 years. This kind of study may be the first of its kind for soil fauna populations.

MATERIAL AND METHODS

The study area comprises about 48 ha declared by UNESCO/MAB as the Omayed Biosphere Reserve in 1981. It is located at about 83 km W of Alexandria and 10 Km S of the seashore. It has been classified as part of the "Attenuated Xero-Mediterranean climatic province of Egypt" (Ayyad et al. 1984). Vegetation consists mainly of Anabasis articulata, Thymelaea hirsuta, Artemisia monosperma and Gymnocarpos decanderum perennial shrubs, with a number of other shrubs and herbs (Ayyad and El-Kadi, 1982). An experiment of protection from grazing was carried out since 1974. In 1977, a part (14 ha) was separated and subjected to 50% grazing of the rate freely practiced outside the exclosure (100% grazing pressure, G.P.). At the same date, wo other plots, each of 14 ha, were also fenced. One was subjected to 50% G. P. and the other to 25% G. P. (Ayyad ana El-Kady, 1982). Grazing animals are sheep and goats.

The method of sampling soil mesofauna was described by Ghabbour et al. (1977) and Ghabbout and Hussein (1978). Samples were taken from under the above mentioned 4 shrub species in the grazed and completely protected plots during summer 1987. Selection of shrubs was at random. Five shrubs were sampled from each plant species from grazed and completely protected plots with 0% G. P., except protected Thymelaea (n=2) and grazed Artemisia (n=4) because of their very small numbers. The diameter of each shrub was measured, the mean radius of the shrub was determined by half the average of the largest and smallest diameter of that shrub. Population density is calculated by dividing

number of individuals by the area in square meter.

Treatment of data :

Absolute frequency was calculated as a percentage of the number of sampling units in which the species occurs and the number of sampling units comprising the total samples (Wallwork, 1976).

Shannon-Wiener index of diversity is calculated as :

H = - Pi 1n Pi, where Pi is the proportional abundance of the ith species to the total number of individuals of all species (Deshmukh, 1986).

The species/area and density/area relationships can be fitted by the curve Y = cAz, where Y is the number of species or population density, A is the area, and c and z are two constanrts. Transforming area, number of species and population density to logarithms, results in the regression equation lnY=lnc+zlnA. Given a series of values of Y and A, a linear regression is calculated and the two parameters c and z are estimated (Preston, 1962; as cited by poole, 1974).

RESULTS AND DISCUSSION

The canopy area of each sampled shrub, number of species and total population density are shown in Table (1). Analysis of variance of these data indicated that there is no significant difference between canopy area of sampled shrubs of the completely protected plots. On the other hand, significant differences occurred between the area of the sampled shrubs of the grazing plots. Thymelaea has the largest canopy area and largest species number, followed by Artemisia, Anabasis and Gymnocarpos. Gymoncarpos has the smallest area in both protected and grazed plots, but with relatively higher species number (5) in grazing plots. Application of analysis ofvariance for the pooled data of the sampled shrubs in both completely protected and grazed plots, indicated that shrubs of the grazing plots have larger canopy area than those of the completely protected ones, except for Gymnocarpos (0.168 m2 for grazed and 0.258 m2 for completely protected plots). The effect of protection and controlled grazing on the vegetation of the Omayed Biosphere Reserve was

Table (1) Area in meter square (A), number of species (S) and total population density (P, individuals/m^2) in grazed and completely protected plots.

n	Anabasis			Thymelaea			Artemisia			Gymnocarpos		
	A	S	P	A	S	P	A	S	P	A	S	P
	Grazed											
1	0.385	1	2.60	1.039	4	16.35	0.950	0	0	0.126	1	7.94
2	0.472	3	6.36	0.260	0	0	0.636	3	4.71	0.142	1	7.04
3	0.636	1	1.57	0.503	1	1.49	0.196	2	10.20	0.159	3	25.16
4	0.601	1	1.66	1.227	1	0.81	0.601	0	0	0.196	3	35.72
5	0.503	3	5.97	0.567	1	1.76	-	-	-	0.216	5	41.67
$\bar{x}$	0.519	1.8	3.63	0.719	1.4	4.08	0.596	1.2	3.73	0.168	2.6	23.51
SE	0.05	0.5	1.05	0.18	0.7	3.08	0.15	0.7	2.43	0.02	0.7	7.05
	Completely protected											
1	0.358	0	0	0.535	3	16.82	0.503	1	1.99	0.216	2	13.89
2	0.747	3	5.36	0.059	0	0	0.785	1	1.07	0.196	2	10.02
3	0.283	2	17.67	-	-	-	0.503	1	3.98	0.332	2	12.05
4	0.356	1	2.79	-	-	-	0.332	1	3.01	0.238	0	0
5	0.332	2	9.03	-	-	-	0.385	0	0	0.307	1	6.51
$\bar{x}$	0.416	1.6	6.97	0.297	1.5	8.41	0.502	0.8	2.01	0.258	1.4	8.49
SE	0.08	0.5	3.06	0.24	1.5	8.41	0.08	0.2	0.70	0.03	0.4	2.45

SE = 1 standard error

Table (2) Shannon-Wiener index of diversity of soil fauna under shrubs in grazed and completely protected plots.

	Grazed	Completely protected
Anabasis	1.68	1.64
Thymelaea	1.42	0.71
Artemisia	1.44	0.93
Gymnocarpos	1.60	0.81
Herbivores	0.88	0.00
Plant detritivores	1.30	1.17
Animal detritivores	-	-
Predators	0.75	0.47
Treatments	1.97	1.51

reported upon by Ayyad El-Kadi (1982). They mentioned that protection resulted on increase in density, vigour and cover of the vegetation, but some plant species exhibited a negative response to protection. They added that grazing both destroys and improves rangeland ecosystems and defoliation is not the only effect that grazing animals have on those ecosystems. Light nibbling and removal of standing dead shoots by those animals usually promote vigour and growth of defoliated plants (Pearson, 1965; cited by Ayyad and El-Kadi, 1982).

Wall work (1976) mentioned that if the investigation is concerned with comparisons of entire groups of species, as it would be in studies seeking to delimit one natural grouping from another, the effective number of sampling units (shrubs in the present study) will be determined from a curve such as that shown in Fig. (1). This type of curve is known as the "species-area" or "minimal-area" curve and it is used to determine the minimum number of sampling units (shrubs), which will yield a high proportion of the total number of species present in the sampling unit (s). This curve is used in this study to compare the number of sampled shrubs and species present in both completely protected and grazed plots. Completely protected plots attained a nearly constant number of species after six sampled shrubs. For grazed plots, the curve rapidly increased in the number of species and attained constant number of species at sampling shrub number 17. The free grazing plot has therefore higher species number than the completely protected plots.

Calculating Shannon-Wiener diversity index (Deshmukh, 1986), for each shrub of both treatments indicated that shrubs of the grazing plots have diversity indices higher than shrubs of completely protected plots (Table 2). In general, diversity in the free grazing plots is higher than in completely protected plots. The free grazing plot has 12 different soil animal species while the completely protected plot has only 8 different species. When comparing total population density of these species, the grazing plot has mean total density of 9.02/m2, higher than that of 6.15m2 for the completely protected plot (Table 3). The combination of the two above mentioned factors leads to higher diversity in grazed than in completely protected plots. Odum (1971) discussed the

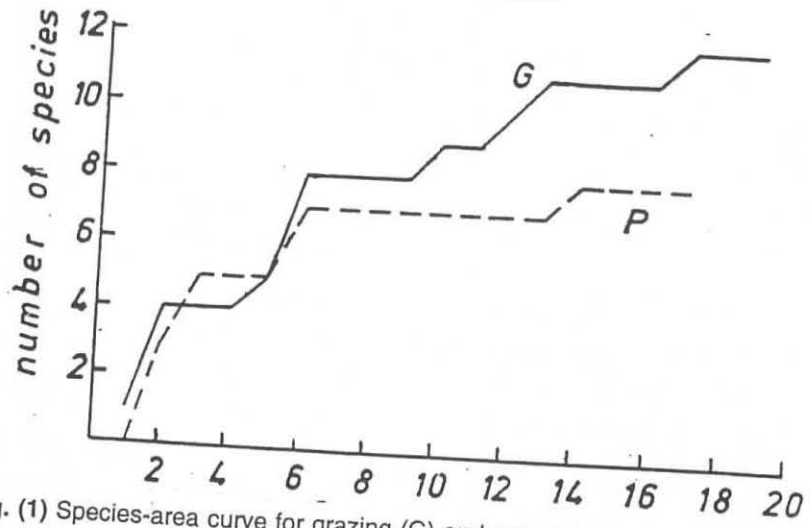

Fig. (1) Species-area curve for grazing (G) and completely protected (P) plots. Cumulative number of species and cumulative number of sampling units.

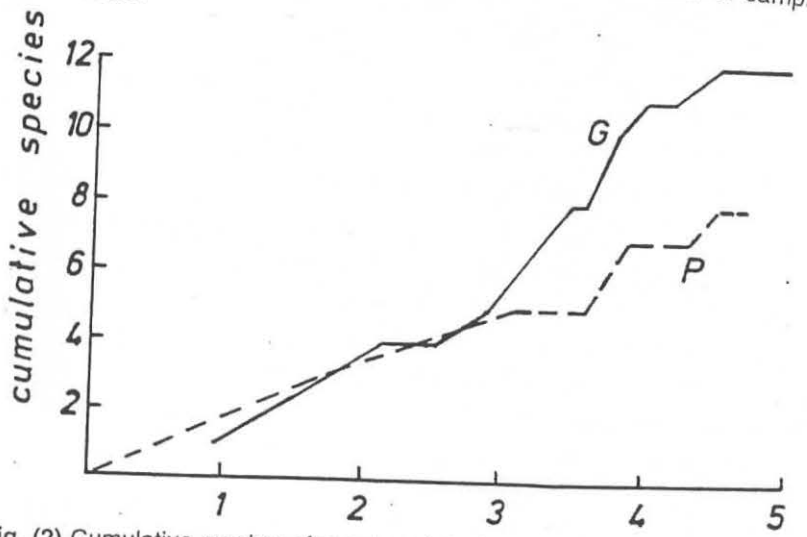

Fig. (2) Cumulative number of species plotted against ln of cumulative number of individuals in grazed (G) and completely protected (P) plots.

Table (3) Mean absolute frequency (AF) and mean density (M, individuals/m^2) of soil fauna in grazed and completely protected plots.

Species	No	Grazed AF	Grazed M	Completely protected AF	Completely protected M
Mollusca					
Eremina desertorum	1	16	1.62	6	0.30
Dictyoptera					
Heterogamia syriaca	2	42	1.91	47	3.02
Hymenoptera					
Sphegidae	3	16	0.30	-	-
Formicidae					
Monomorium salomonis	4	5	0.61	-	-
Coleoptera					
Carabidae					
Bradycellus lusitanicus	5	5	0.10	12	0.37
Scarites buparius	6	21	1.18	-	-
Curculionidae					
Otiorhynchus sp.	7	37	2.34	18	1.22
Tenebrionidae					
Crypticus murinus	8	11	0.51	-	-
Dendarus piceus	9	5	0.14	24	0.78
Erodius gibbus	10	5	0.08	6	0.11
Machlopsis crenatocostata	11	5	0.10	-	-
Scarabaeidae					
Psammobius porcicollis	12	11	0.13	12	0.27
Scorpions	13	-	-	6	0.08
	Total		9.02		6.15

relationship between number of specis and number of individuals counted and he found that if the cumulative number of species is plotted against the logarithms of the cumulative of the individuals counted, something approaching a strainght line may result. The relationships of both completely and grazed are not strictly straight lines (Fig. 2). This may be due to the presence of zero sampled shrubs followed by one with higher clumps of such species as well as due to the size of the sample (Odum, 1971). From Fig. (2), one can use the ratio of cumulative number of species and log of individuals counted as indices to compare species diversity (Odum, 1971) in different treatments and at different stages. This ratio was the same in completely protected and grazed polts till the middle of the figure, then a rapid increase occurred in this ratio in the grazing plot. This indicates that as the sample size increases, the diversity of the grazing plot increases.

Frequency and density vary independently as functions of the horizontal distribution pattern, and yet they usually behave in very similar ways: as the density of a species increases, so does its frequency (Wallwork, 1976). This is illustrated by data presented in Fig. (3). Wallwork (1976) suggested an arbitrary categorization of species as "accidental", "accessory", "constant" and "absolutely constant" with constancy ratios of 0-25, 25-50, 50-75 and 75-100% respectively. Species frequency of the present study never exceeds 50%. Thus, all species belong to accidental and accessory categories. Most species may be considered as accidental, except Otiorhynchus sp. in the grazed plots and Heterogamia syriaca in both treatments. The latter species is a major components of the desert ecosystems of the Mediterranean coast of Northern Egypt (Ghabbour et al., 1977 and Ghabbour and Mikhail, 1978). H. syriaca was found in 1980 summer sampling (6 years after protection) to decrease as a result of protection in the Omayed plots (Concela da Fonseca et al., 1984; Ghabbouret al., 1991 and Mikhail et al., 1991). However, the 1978 summer sampling (13 years after protection) showed that it rather increased again in protected plots (Mikhail, 1991).

In Fig. (4) the number of species and total population density is plotted against area of sampled shrubs. Transforming area and both number of species

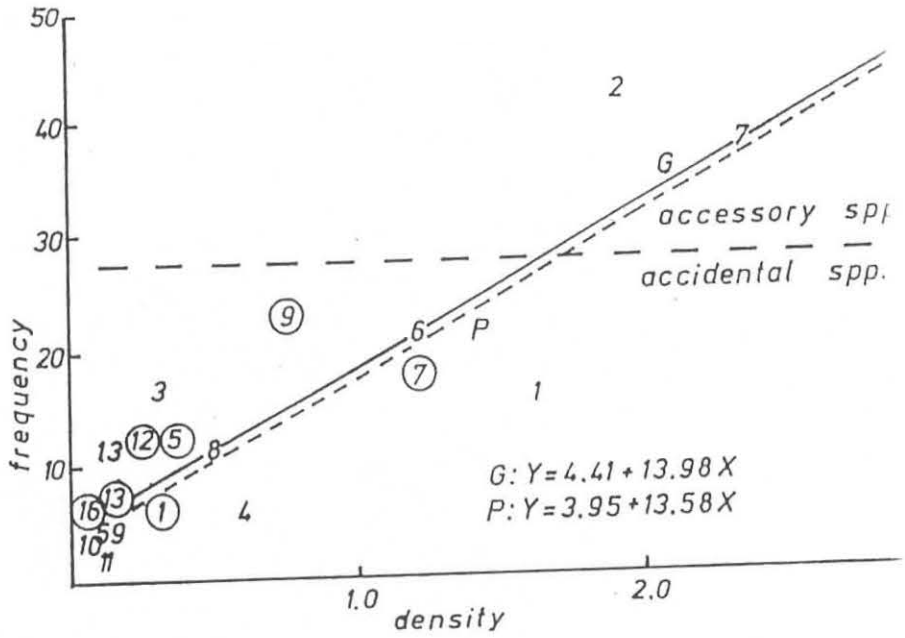

Fig. (3) Regression of frequency on population density of soil fauna in g (G) and completely protected (P) plots. Symbols : number of sp (1-13) as in Table (3), encircles numbers represent species asso with completely protected plots, other numbers represent speci sociated with grazed plot.

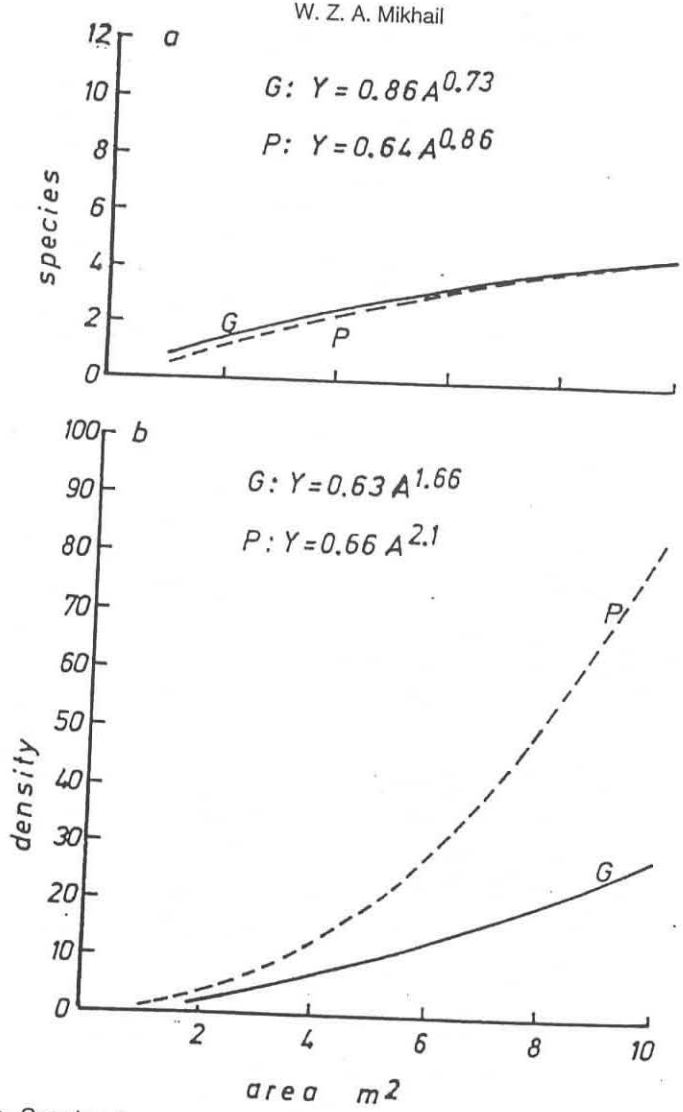

Fig. (4) a- Species / area relationships, b- Density/area relationships, in grazed (G) and completely protected (P) plots.

and total population density to logarithms will produce a non-linear relationshi (Poole, 1974). The two constants each have a simple biological interpretation : provides an estimate of the number of species or density per unit area, and th power z indicates how fast new species or individuls are added with increasin area (Usher, 1986). Species/area relationships are identical in the tw treatment, but the grazed plots may support very few species more than th completely protected ones (Fig. 4a). Density attains a positive relationship wit area in both treatments, but this relationship is stronger in completely protecte plots than in the free grazed one (Fig. 4b). The constant c seems to be the sam in both treatment for species/area and density/area relationships. In case c species/area relationships, the constant z seems to be equal but greatly differ in density/area relationships. Addition of new individuals to the completel protected plot is greater than of grazed area (Fig. 4b), while addition of nev species is the same in both treatments. This phenomenon is probably due to th fact that shrubs in the grazed plots have canopy areas lager than in th completely protected ones. Prolonged protection from grazing minimize animally produced resources (faeces and urine) in the completely protecte plots. On the other hand, there is a variety of resources in the free grazing plots The increase of plant resources in the protected area does not compensate fo the decrease in animally produced ones in the grazed area since the forme resources are comparatively poorer in nitrogen concent. Trampling by grazin animals increases soil compactness and reduces penetrability and moistur permeability. As most of species are accidental (Table 3 and Fig. 3), ground-dwelling animals may tend to partition habitats horizontally rather tha vertically (Louw and Seely, 1982), some using open spaces between vegetatio (now covered with denser annuals), and others using spaces near or in specifi vegetation types. The above mentioned factors may explain why the rate a which number of individuals increases is higher in the completely protected are than the grazed one.

Calculating Shannon-Wiener index of diversity for trophic (functional) group in both treatment (Table 2) shows that it is higher for detritivores and predators i the free grazed area than in the completely protected one. Herbivores ar

represented only by one species, a sanil, which disappeared with protection, at least at time of sampling, so diversity of this group (herbivores) cannot be calculated, However, herbivores were highly associated with protected areas at the beginning (Cancela da Fonseca et al., 1984; Gabbour et al., 1991 and Mikhail et al. 1991).

In this study, a general decrease in diversity is observed with complete protection (for 13 years), either according to faunules under shrubs or as regards functional groups of soil fauna. Ghabbour et al. (1985) had anticipated changes in diversities of functional groups of soil fauna as a result of changing grazing land ecosystems into agro-ecosystem. Similar changes should also occur in these ecosystems as a result of management, either by partial, rotational, or complete protection for short or for long periods. Monitoring of such changes in diversity, not only for the total fauna, but also for their functional groups, should be an essential component of world-wide bio-diversity monitoring programmes. More comparisons will be needed in order to obtain a clear picture of such changes, as a result of natural or man-made perturbations of ecosystems.

ACKNOWLEDGEMENTS

The writer wishes to offer thanks to Foreign Relations Co-ordination Unit, Supreme Council of Universities, Cairo, Egypt, for finacial support (FRCU Grant 842091), and Prof. M.A. AYYAD for facilities offered at the Omayed Biosphere Reserve during the study.

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الملخص العربى

عشائر حيوانات التربة فى مساحات الرعى الحر والممنوعة منه فى محمية العميد للمحيط الحيوى

٢- علاقة عدد الانواع بالمساحة التى تغطيها الشجيرات

وفائى زكى عازر ميخائيل

قسم الموارد الطبيعية – معهد البحوث والدراسات الافريقية – جامعة القاهرة

تقع منطقة البحث فى قرية العميد على بعد ٨٣ كم غرب الاسكندرية وعلى مسافة ١٠ كم من شاطئ البحر المتوسط وهى منطقة يسود فيها رعى الأغنام والماعز.

وقد سورت منطقة مساحتها حوالى ٢٠ هكتار ومنع الرعى فيها لمدة ٣ سنوات من ١٩٧٤ الى ١٩٧٧ ثم قسمت الى جزءين أحدهما مساحته حوالى ١٤ هكتار سمح فيه بالرعى بضغط رعوى قدره نصف السائد فى المنطقة عموماً واستمر المنع فى الجزء الأخير. وفى نفس الوقت أضيفت مساحتان أخريان كل منهما حوالى ١٤ هكتار أيضاً وسمح فى الأولى برعى قدره نصف السائد وفى الأخرى بضغط قدره ربع السائد.

ويحلل هذا البحث نتائج الدراسة التى أجريت فى عام ١٩٨٧ لدراسة أثر الحماية المتصلة (لمدة ١٣ عاماً) على أنواع وكثافة عشائر حيوانات التربة وعلاقتها بالمساحة التى تغطيها الشجيرات. وقد أخذت العينات بغربلة التربة تماماً من أسفل أربعة أنواع من النباتات الشجيرية أو تحت الشجيرية وهى المتنان والعجرم والشيح والجرد من كل من المعاملة الأولى (المحمية تماماً من الرعى لمدة ١٣ عاماً) والمنطقة الخارجية ذات الرعى الحر (أى حيث الضغط الرعوى ١٠٠٪).

أظهرت نتائج الدراسة أن تنوع عشائر حيوانات التربة أعلى فى المناطق ذات الرعى الحر عنه فى المناطق المحمية تماماً من الرعى. كذلك فان منحنى العلاقة بين عدد الأنواع والمساحة التى تغطيها الشجيرات توضح أن الفارق ضئيل بين المعاملتين وأن معدل زيادة الانواع مع المساحة التى تغطيها الشجيرات واحد فى كلتا المعاملتين بينما نجد أن منحنى العلاقة بين عدد الافراد والمساحة التى تغطيها الشجيرات يختلف فى المناطق المحمية من الرعى عن تلك ذات الرعى الحر وأن معدل زيادة الافراد مع المساحة التى تغطيها الشجيرات أعلى فى المناطق المحمية من الرعى عنه فى مناطق الرعى الحر.